Solution of ECE 300 Test 3 F08

1. Answer the following questions about the circuit below.

   (a) How many branches are there? _____ 10

   (b) How many nodes are there? _____ 6

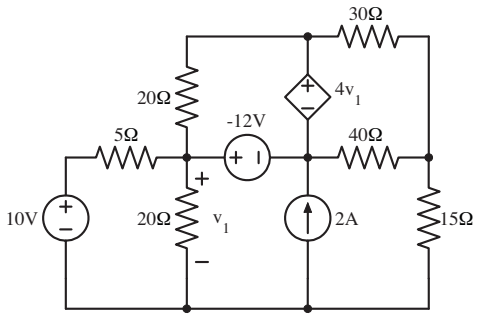
   (c) How many meshes are there? _____ 5

   (d) How many supernodes are there? _____ 2

   (e) How many supermeshes are there? _____ 1

   (f) In writing nodal equations for this circuit, how many equations should you write for the sum of currents leaving a node or supernode equals zero (KCL)? _____ 2

   (g) In writing mesh equations for this circuit, how many equations should you write for the sum of voltages around a mesh or supermesh equals zero (KVL)? _____ 4



2. Fill in the blanks below in the nodal and mesh equations.

$$\frac{\square}{3}+\frac{\square-v_2}{\square}=0$$

$$\frac{\square}{5}+\frac{\square}{12}+\frac{v_2-\square}{5}=0$$

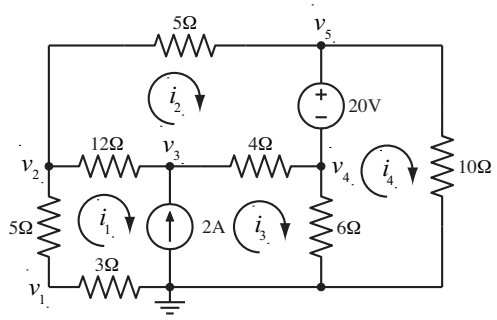
$$\frac{\square}{12}+\frac{v_3-\square}{\square}=\square$$

$$\frac{\square}{6}+\frac{\square}{4}+\frac{\square-v_2}{5}+\frac{v_5}{\square}=0$$

$$5\square+\square(i_1-i_2)+4\square+6\square+\square i_1=0$$

$$\square i_2+\square+4\square+12\square=0$$

$$\square(i_4-i_3)-20+10\square=0$$



$$\frac{v_1}{3}+\frac{v_1-v_2}{5}=0$$

$$\frac{v_2-v_1}{5}+\frac{v_2-v_3}{12}+\frac{v_2-v_5}{5}=0$$

$$\frac{v_3-v_2}{12}+\frac{v_3-v_4}{4}=2$$

$$\frac{v_4}{6}+\frac{v_4-v_3}{4}+\frac{v_5-v_2}{5}+\frac{v_5}{10}=0$$

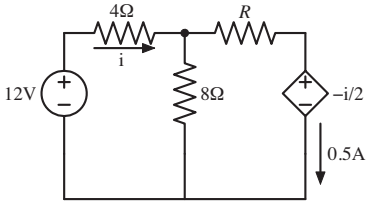
$$5i_1+12\left(i_1-i_2\right)+4\left(i_3-i_2\right)+6\left(i_3-i_4\right)+3i_1=0$$

$$5i_2+20+4\left(i_2-i_3\right)+12\left(i_2-i_1\right)=0$$

$$6\left(i_4-i_3\right)-20+10i_4=0$$

3. Find the numerical value of *R*. $R =$ _____

(The numerical value of the voltage in volts across the dependent voltage source is equal to the negative of half of the numerical value of the current i in amperes.)



Assign v_1 as the node voltage at the intersection of the three resistors and the bottom node as the reference node.

$$\frac{v_1-12}{4}+\frac{v_1}{8}+\frac{v_1-\left(-i/2\right)}{R}=0$$

$$i=\frac{12-v_1}{4}\qquad 0.5=\frac{v_1-\left(-i/2\right)}{R}$$

$$\frac{v_1-12}{4}+\frac{v_1}{8}+0.5=0\Rightarrow\left(3/8\right)v_1=2.5\Rightarrow v_1=20/3\text{ V}$$

$$i=\frac{12-20/3}{4}=4/3\text{ A}\ ,\ 0.5=\frac{20/3-\left(-2/3\right)}{R}\Rightarrow R=\frac{20/3-\left(-2/3\right)}{0.5}=\left(44/3\right)\Omega$$

Voltage drop across 4 ohm resistor is 16/3 V. Current through the 8 ohm resistor is 5/6 A. Voltage drop across *R* is 22/3 V. Dependent voltage source voltage is –2/3 V. KVL and KCL are satisfied everywhere.

Alternate Solution:

Assign two mesh currents, i_1 in the left mesh and i_2 in the right mesh. Then immediately we know that $i_2=0.5$. The two mesh equations are

$$-12+4i_1+8\left(i_1-i_2\right)=0$$

$$8\left(i_2-i_1\right)+Ri_2+\left(-i/2\right)=0$$

From the first mesh equation

$$-12+4i_1+8\left(i_1-0.5\right)=0\Rightarrow 12i_1=16\Rightarrow i_1=4/3\Rightarrow i=4/3$$

From the second mesh equation

$$8\left(1/2-4/3\right)+R\left(1/2\right)+\left(-2/3\right)=0\Rightarrow R=2\left(22/3\right)=\left(44/3\right)\Omega$$